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The Navy and Marine Corps Aviation Team is a major component of our nation's overall warfighting capability and provides a flexible forward presence and deterrence to preclude conflicts and preserve the peace. Our nations need for a responsive, dynamic, unencumbered, forward-deployed, expeditionary force to provide true flexibility for rapid response will continue to be critical in the 21st century. As a result, our vision is a warfighting who is fast, lean, mobile, affordable, sustainable, and prepared for battle with total battlespace situation awareness and information assurance. We are adapting our acquisition processes to take greater advantage of commercial market forces and make better use of private sector information and technology. We are striving to be agile enough to thwart the adanced asymmetric capabilities of potential adversaries.

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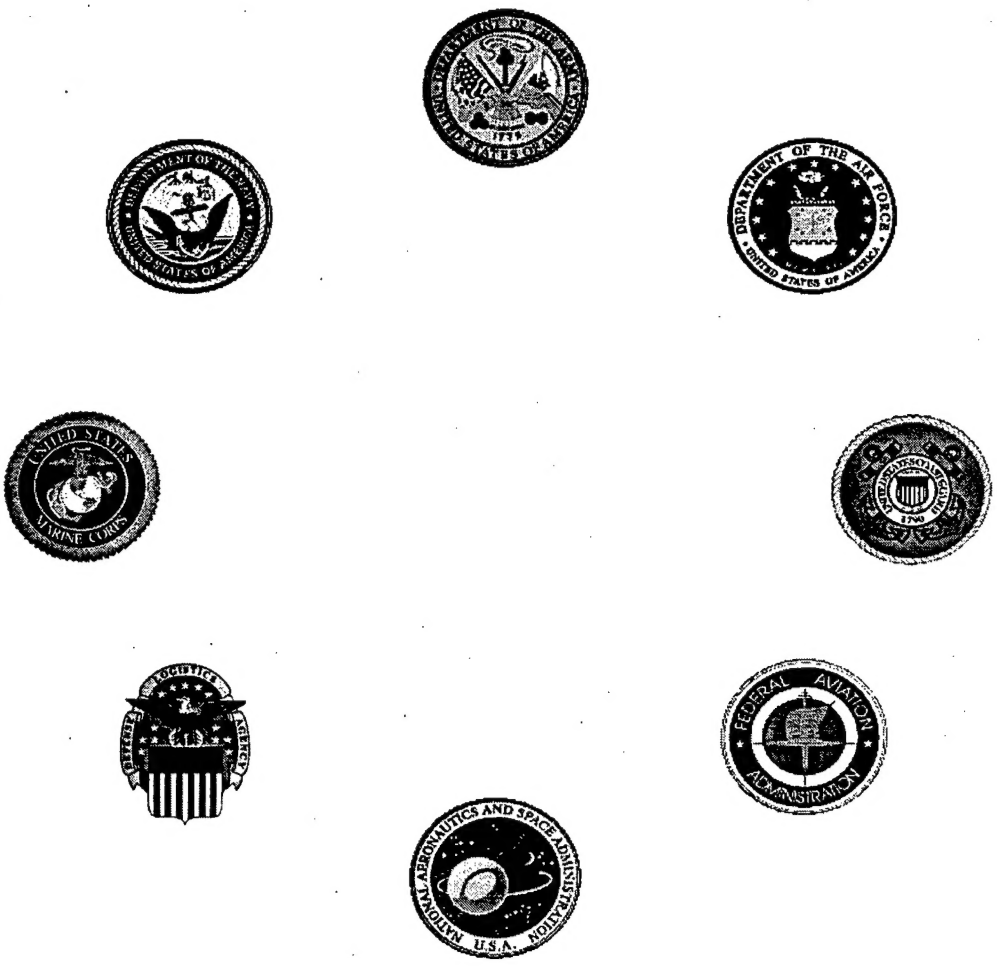

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DEPARTMENT OF NAVY
U. S. NAVY/ U. S. MARINE CORPS

VISION

The Navy and Marine Corps Aviation Team is a major component of our nation's overall warfighting capability and provides a flexible forward presence and deterrence to preclude conflicts and preserve the peace. The unique, and demanding, operating environments in which these forces are required to conduct their missions require a robust Science and Technology (S&T) base to continually enhance Naval Aviation effectiveness and operational readiness to defend against advanced technology threats. Our nation's need for a responsive, dynamic, unencumbered, forward-deployed, expeditionary force to provide true flexibility for rapid response will continue to be critical in the 21st century. As a result, our vision is a warfighter who is fast, lean, mobile, affordable, sustainable and prepared for battle with total battlespace situation awareness and information assurance. The common vision of the Navy and Marine Corps espoused in ...*From the Sea* and *Forward...From the Sea* focuses on "skillfully handled Naval forces" that "enable the United States to exert its influence in the littoral regions of the world." In concert with this, the Marine Corps' focus, as outlined in "Operational Maneuver from the Sea" (OMFTS), is the "full spectrum of challenges" coupled with "the dangers and opportunities created by new technologies." Together, the Navy and Marine Corps are working to adapt the "tradition of maneuver warfare, not merely to amphibious operations, but to all aspects of warfare in, and around, coastal waters." To do this, we are implementing a re-engineered business strategy-from top to bottom-that complements organizations such as the Naval Warfare Centers, the Naval Warfare Development Command and the Marine Corps Warfighting Laboratory, investigating new technologies and leveraging them into a warfighting edge. We are pursuing research, development, test, and evaluation programs that focus on innovative high-payoff challenges, including some with high technical risk. We are adapting our acquisition processes to take greater advantage of commercial market forces and make better use of private sector information and technology. We are striving to be agile enough to thwart the advanced asymmetric capabilities of potential adversaries.

The Marine Corps and Naval Aviation Communities are committed to developing, integrating and delivering greatly needed technology improvements throughout the fleet for the defense of our nation. Through aggressive partnering with other services, defense agencies, industry and leveraging technology already available, our Sailors and Marines will be provided the tools and services they need to conduct their missions effectively, efficiently and affordably.

OVERVIEW OF AGENCY MISSION

The expeditionary nature of naval forces means that we will continue to be the force of choice for crisis response. Our unique ability to provide combat-capable, self-sustained, unencumbered forces on-scene, almost indefinitely, that can influence and "shape" events ashore, will ensure that we can prevent situations from developing into a crisis or conflict. Our ability to achieve and sustain full battlespace dominance will become ever more important. Naval Aviation will play a critical role in ensuring that we obtain and maintain battlespace dominance in future conflicts. The twin centerpieces of naval expeditionary forces are our aircraft carriers with their embarked air wings and our amphibious assault ships with their embarked Marine Forces. The multi-mission aircraft that are part of these units give us the unique flexibility to respond quickly and precisely.

Our aircraft carrier fleet will comprise eleven active and one reserve carriers. The mix of two conventional powered carriers and ten nuclear powered carriers will be attained in the year 2002. Currently there are ten active and one reserve air-wings to support the carrier fleet. Each air-wing comprises 56 high performance F/A-18 Hornet and F-14 Tomcat multiple-mission-capable strike-fighter aircraft. Additionally, the unique electronic capabilities of the EA-6B Prowler, the multi-sensor capabilities of the E-2C Hawkeye, and the surveillance and reconnaissance capabilities of the S-3B Viking and ES-3A Shadow make the air-wing a lethal and capable power projection team. Maritime Patrol Aircraft at the turn of the century will consist of twelve active and eight reserve squadrons flying P-3C Orion aircraft supporting increasing multi-mission anti-surface warfare requirements.

The Marine Corps will field three active and one reserve wings. The Marine Corps air-wing will consist of high performance F/A-18C/D and AV-8B Harrier aircraft for offensive air support, EA-6B aircraft for electronic warfare and KC-130 Hercules aircraft for aerial refueling as well as CH-46 / 53, AH / UH-1 and the V-22 in 2001 for Assault Support.

STRATEGIC GOALS AND OBJECTIVES

Network Centric Warfare

Network Centric Warfare (NCW) is the vision for future Navy operations. NCW is based on the ability of a widely distributed, self-synchronizing force to mass effects when and where desired. The force, based on timely, accurate, common, shared information, requires high quality, widely distributed and netted sensors; a streamlined command structure; and units capable of autonomous operation and unity of effort. Properly implemented, NCW increases the speed, precision, and effectiveness of Naval forces. It is applicable to all levels of warfare and contributes to the coalescence of strategy, operations, technology, and tactics; it is transparent to mission, force size and composition, and geography.

NCW derives its power from the robust networking of a well informed but geographically dispersed force. It is enabled by the following attributes: highly webbed information services; timely access to all relevant and appropriate information sources; value-added, automated command

and control processes; netted, integrated sensors that are closely coupled in time to the shooters and command and control processes; and weapons reach with adequate precision and speed of response.

Affordability

Ownership Costs and System Affordability are major Navy and Marine Corps emphasis areas. As such, Naval Aviation programs are addressing affordability in a variety of different ways. For example, engine acquisition costs and maintenance costs are reduced by Navy efforts to incorporate advanced manufacturing technology (MANTECH) techniques into the development programs, improve the design tools to better predict component life and durability, reduce parts count by utilizing simple design schemes, increase stage loading, and increase system performance.

Modernization

For both the Navy and Marine Corps, modernization is of utmost importance. The Marines are currently fielding the V-22 tilt-rotor aircraft as the replacement for the CH-46E Combat Assault Helicopter and the Joint Strike Fighter (JSF) is their most important fixed-wing modernization program. The Marine Corps has made the fiscal decision to skip a generation of tactical aircraft by not purchasing the F/A-18E&F, and are reliant upon the JSF being delivered on schedule.

Technology Transitions

A fundamental goal and objective of the Naval Aviation community is to facilitate, in a timely manner, the transition of state-of-the art technologies which will lead to superior operational readiness and warfighting capabilities for the Naval Operating Forces. A number of the Naval Air Systems Command's business processes have been, or are currently being, re-engineered to promote increased partnering, requirements awareness, and goals visibility, as well as to establish performance benchmarks to measure our successes. The Navy's Systems Commands (SYSCOM), in their acquisition roles, will lead the new Future Naval Capabilities (FNC) process to enhance our effectiveness in transitioning technology to our fleet systems.

Joint Efforts

Increasingly, the Navy is moving to more joint research, development, procurement and operations. In the S&T area, there is increased cooperation and interdependency in DoD S&T investment. The Joint Strike Fighter (JSF), X-31 and unmanned aerial vehicles (UAV) are examples of programs where the services have successfully been able to team their S&T efforts for mutual benefit. More recently, the Navy has approved participation in a joint study of a naval concept of operations for a future Unmanned Combat Air Vehicle (UCAV) with DARPA.

The Department of the Navy coordinates its S&T programs through the DoD S&T Reliance process which was started in the early 1990s. The Reliance process provides a forum where S&T programs are planned, balanced and reviewed jointly, to ensure that unnecessary duplication is eliminated and to ensure compliance with top-level Defense Strategy and Planning Guidance. Through the Reliance process Technology Area Reviews and Assessments (TARA) are conducted to monitor the state of the art in technology as well as to provide frequent interactions among DoD components. There are presently 14 active technology panels (such as Air Platforms, Weapons, Human Systems, Sensors, Electronics). Reliance is overseen by the Deputy Director, Defense Research and Engineering (DDR&E); this office is also responsible for preparing the Joint Warfighting S&T Plan, Defense Technology Area Plans (DTAP), Basic

Research Plan (BRP) and the Defense Technology Objectives (DTO). The latest versions of these documents can be found at the DDR&E web site (URL = https://ca.dtic.mil/dstp/).

NAVAL AVIATION TECHNOLOGY MAJOR THRUST AREAS

Air Vehicles

The focus of the Air Vehicle technology thrust area is those technologies that have the greatest impact on the airframe and on the air vehicle aerodynamics and control, especially those that are unique or peculiar to Naval Aviation operations. Current investments include unique aerodynamic concepts; aerodynamics of V/STOL configurations; flight control technologies, especially those related to reconfigurable flight control systems and self-diagnostic systems; aircraft handling qualities for shipboard operations; Uninhabited Combat Air Vehicle concepts; advanced composite structure concepts, and structural life methodologies. Through a variety of vehicles, such as the Air Platforms DTAP, Navy air vehicles S&T investments are generally made in collaboration with one or more partners, e.g., AFRL, NASA, DARPA.

Avionics & Sensors

A major objective of the Navy and Marine Corps is to make avionics and sensor systems lighter and smaller for the functionality required and to have a greater degree of component commonality with other, especially commercial, systems. The Department is moving away from federated avionics systems to distributed systems where common processor modules and shared apertures can be used with great cost and support advantage. A major focus is on dual-use systems that can adapt to emerging communication, navigational, safety and computing concepts, as well as promote safe and efficient flight in the U.S. civil and European airspaces. The Department's interest in advanced avionics and sensor technologies for future generation systems is focused on those technologies that will allow the resulting systems to be fully compatible with its network centric warfare strategy and provide the warfighter with a common tactical battlespace picture. Some specific technology investment areas include the following: advanced radio frequency sensor systems, especially wide band systems and electronically scanned arrays; low probability of intercept sensors; signal processing techniques for synthetic aperture radar sensors; advanced target recognition technologies; advanced imagery compression and transmission technologies; advanced electronic warfare technologies; advanced identification friend or foe technologies; precision identification and targeting technologies; ASW sensors and signal processing techniques for littoral waters; and advanced laser hardware and signal processing techniques.

Crew Systems

The Crew Systems thrust area includes all aircraft flight crew systems technologies, from the human engineering of equipment and displays for aircraft flight crew to the design of hardware and software interfaces for aircraft maintenance personnel. Current technology focus areas are cockpit/crew station integration, emergency egress systems, life support systems, crashworthy systems, personal protection/mission enhancement (especially eye protection), and human systems integration.

Interoperability and C4ISR

A major emphasis area for the Navy and Marine Corps is the development of the technologies that will provide an interoperable and secure C4ISR (command, control, communications, computer, intelligence, surveillance and reconnaissance) infrastructure that encompasses both strategic and tactical needs. This fully interoperable C4ISR infrastructure will provide total battlespace awareness and information assurance with real-time intelligence from sensor to shooter. It will be a major enabler for the Department of the Navy's Network Centric Warfare strategy.

Materials & Structures

The Materials & Structures thrust area provides the Department with a broad range of critical naval technologies for air vehicles, propulsion, avionics, support equipment, and weapons. Inherent in all these is the need for light, durable, corrosion resistant, high performance materials (metallic and composite) and structures and the respective manufacturing and repair/maintenance processes. Research is being conducted to understand the fundamental phenomena associated with material and structural failure, both the initiation of the failure and its subsequent growth or progression. Concerning system support, technology needs include the equipment and techniques for nondestructive inspection and test and corrosion control to provide cost effective, long life operation and support in the maritime environment.

Propulsion & Power

The Navy aircraft propulsion program is highly focused to develop the appropriate propulsion and power systems technologies for future Navy and Marine Corps fighter/attack aircraft to significantly improve Naval power projection, conflict deterrence, and fleet defense capability. The primary technology emphasis areas being explored are in STOVL and/or V/STOL capabilities, affordable multi-mission aircraft, increased aircraft standoff range, and increased penetration speed. Naval operational requirements present unique challenges in each of the main technology component areas of the gas turbine engine (compression, combustion and turbine systems) as well as in the general areas of controls and mechanical systems.

The Navy's power systems program develops technologies that

(1) Produce weight savings for the electrical and thermal management systems in aircraft systems
(2) Improve electrical and thermal efficiencies
(3) Improve secondary power system reliability
(4) Provide large quantities of electrical power for future directed energy weapons
(5) Dramatically reduce maintenance of electrical and thermal management systems.

The goal of this effort is to develop components that can be transitioned to legacy aircraft in need of reliability improvements and weight savings at minimum cost. An example of one major technology area being explored under this effort is the More Electric Aircraft (MEA) concept. The MEA concept uses advanced electric power system components and electric actuators to eliminate present day aircraft hydraulic, pneumatic and mechanical secondary power systems.

Integrated Systems Support

Integrated Systems Support (ISS) is critical to the day-to-day operational effectiveness of the aviation component of the Naval Fleet. ISS includes all the systems, subsystems, equipment, processes, and technologies which collectively provide the operational, servicing, and maintenance support for naval aviation afloat and ashore. Technology emphasis areas are: seabased aircraft operations technology (e.g., for aircraft launch and recovery, landing guidance); support systems technology (e.g., for aviation support equipment, avionics and non-avionics systems, weapons systems, mission systems, and training); environmental protection and compliance technology; and generic logistics (e.g., for manpower reduction, condition based maintenance, affordability). To identify operational requirements, the naval aviation community conducts a wide range of technology studies for the Navy's diverse Aircraft Platform Interface (API) systems. These studies encompass the areas of systems engineering, test evaluation and performance verification, major platform systems integration, limited manufacturing, systems acquisition, integrated logistics support management, and fleet engineering support.

Total Ownership Costs

Faced with declining resources, aging aircraft inventory and rapidly escalating operating costs, the Naval Aviation Systems Team has taken a leading role in reducing the cost of doing business for the Navy. The challenge is to sustain our superior warfighting capabilities, improve Fleet readiness, and ensure that the Navy can maintain our aviation superiority well into the future. Total Ownership Cost (TOC), as defined for the Assistant Secretary of the Navy (Research, Development, &Acquisition) Strategic Plan, includes all costs associated with the research, development, procurement, operation, logistical support, and disposal of an individual weapon system, including the total supporting infrastructure that plans, manages, and executes that weapon system program over its full life. Given this guidance, the Naval Aviation community is focusing a portion of its S&T resources on technologies that can be implemented affordably to reduce the operating and support costs of current inventory systems. Technologies that reduce maintenance time and increase the effectiveness of maintenance personnel are especially important.

Training Systems

The development of advanced, state-of-the-art training systems is critical to fleet needs and is a major objective of the Naval Air Systems Command (URL = http://www.navair.navy.mil/). The Naval Air Warfare Center Training Systems Division (NAWCTSD, Orlando, FL) is a cornerstone of the National Center of Excellence for Simulation and Training (URL = http://www.ntsc.navy.mil/AboutUs/Excellnc.htm). The Training Systems Division specializes in training systems, human performance measurement, learning and simulation technologies in virtual environments, modeling and simulation, electronic environments as well as dual-use technology development. As the principal Navy center for Naval training systems, the TSD is a major national asset in that it provides R&D, Acquisition, fully integrated life-cycle support and critical inter-service coordination for training systems in support of other defense agencies and services (Army, Air Force, Coast Guard, etc).

Weapons Systems

The Navy and Marine Corps are focusing on a variety of state-of-the-art offensive and defensive weapon technologies that are long-range, high precision, all weather, low-cost, robust

and reliable against time-critical, hardened, fixed and moving targets. The weapons program has a highly focused mission area structure which is built on the Office of Naval Research Air & Surface Weapons Technology (ASWT) program goals of developing and demonstrating those technologies which will maintain the Naval warfighter's edge in Land Attack and Air Dominance. The technologies will achieve challenging time-phased mission area performance goals, resulting in significant warfighting payoffs. Technologies being developed and demonstrated include highly advanced automatic target recognition (ATR), real-time retargeting (RTR), Global Positioning System (GPS), jam-resistant GPS, and inertial navigation system (INS) technologies. These technologies will allow for the removal of much of the expensive guidance systems from current precision guided munitions and replace them with simpler, cheaper, more reliable systems that will receive updated guidance information in flight. Current developments in advanced wavelet image compression algorithms and data transmission technologies will allow the feeding of targeting information to and from the weapons and aircraft (sensor-to-shooter) in a more efficient and timely manner.

The Navy has a leading role in the Integrated High Performance Turbine Engine Technology (IHPTET) and the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) programs as well. IHPTET is an ongoing National program that is doubling the US military's 1988 propulsion capability. In IHPRPT, the Navy is responsible for tactical rocket propulsion for the entire DoD. The continued focus on, and developments in, missile kinematics, sensor performance and ordnance lethality will help ensure that weapons which are put into service will provide true precision strike as well as give naval aviators the air superiority performance capabilities they require. These weapon technology development efforts are being performed by the Naval Warfare Centers as well as the U.S. Defense industry.

TECHNOLOGY TRANSITION AND INSERTION ROADMAPS

At the present time, the Department of the Navy is implementing a new technology transition process that is expected to impact numerous technology insertion points and the associated platform technology insertion roadmaps. The technology summaries and roadmaps presented here are therefore not definitive but only representative of the technology insertion points and targeted platforms. Programs which afford transition and joint program opportunities include ongoing programs not yet in production as well as conceptual programs.

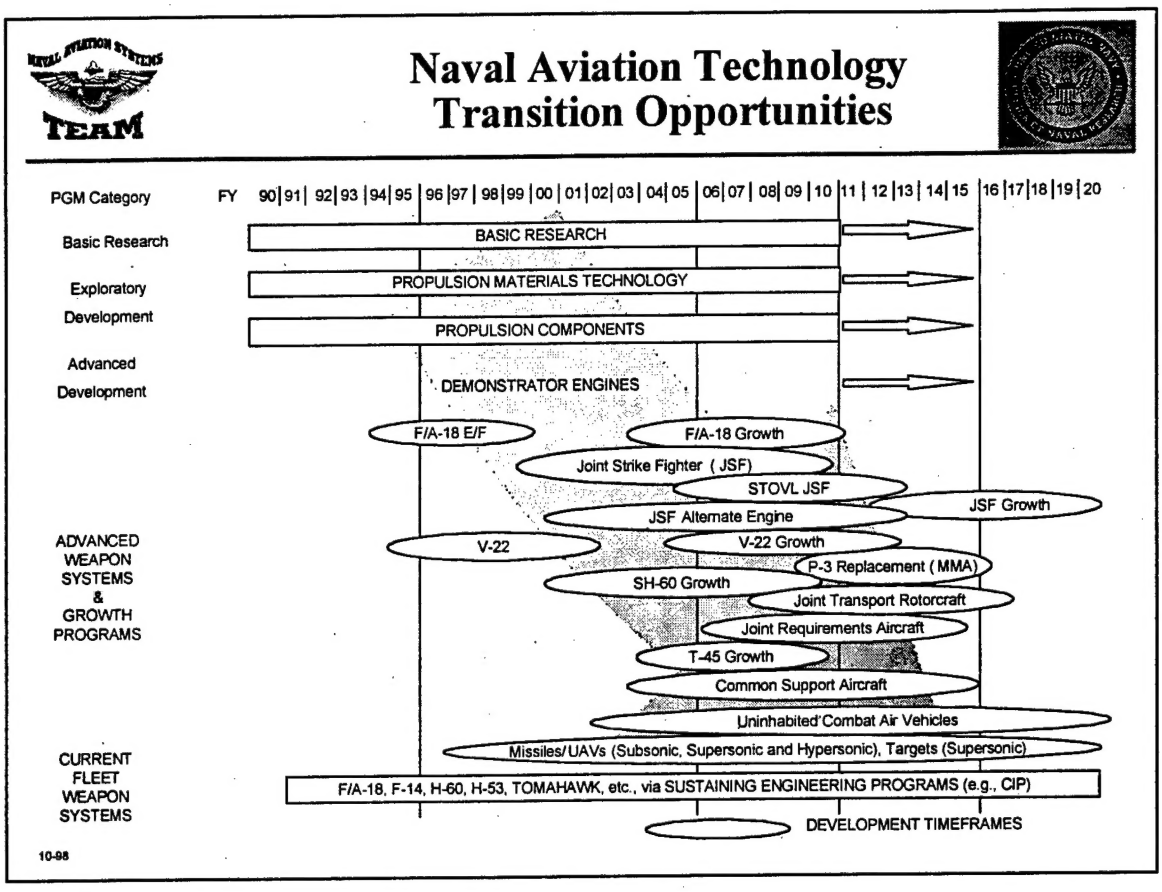

Figure 1 Typical Naval Aviation S&T Transition Roadmap

Figure 1 identifies several Naval Aviation Propulsion and Power technology transition opportunities for Department of the Navy advanced systems. Included are fighter/attack aircraft, patrol/transport/rotorcraft, support aircraft, and missile and UAV systems.

Aircraft Platform Roadmaps

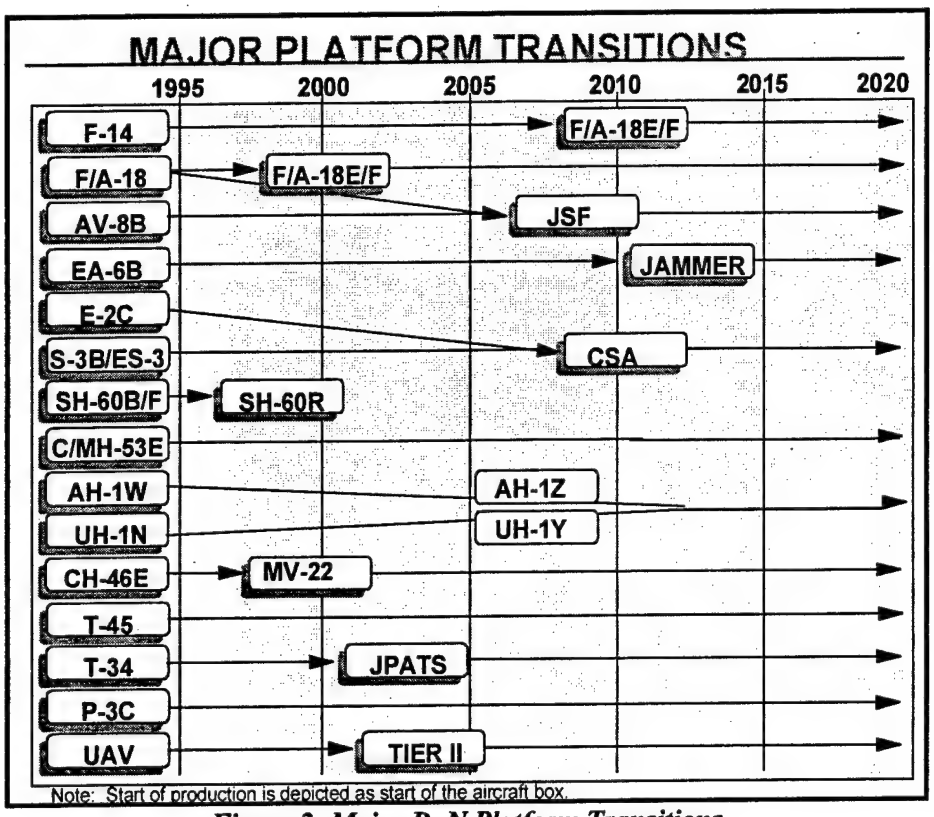

Figure 2: Major DoN Platform Transitions

Figure 2 illustrates platform upgrade and technology transition opportunities for some major Department of the Navy aircraft systems. Included are fighter/attack aircraft, patrol/transport/rotorcraft support aircraft, trainer aircraft and UAV systems. Figure 3 shows primary Marine Corps aircraft platform transitions while figure 4 shows the primary Navy aircraft platform transitions.

The **F/A-18E/F Super Hornet** is the cornerstone of tactical naval aviation for the next two decades. It is currently in production and will replace F-14s as these retire. This modernization development will increase mission radius, endurance, and survivability. It will ensure that throughout the next 20 years the fleet will be capable of countering the evolving threat.

The F/A-18E/F has completed all phases of testing. Operational Evaluation (OPEVAL) began in May 1999 and concluded two weeks ahead of schedule in November 1999. The F/A-18E/F Super Hornet garnered the highest possible rating coming out of OPEVAL when it was declared operationally effective and operationally suitable by the U.S. Navy's Operational Test and Evaluation Force. The OPEVAL report specifically cited the aircraft's key enhancing features (growth, survivability, range and payload) as qualities relative to current fleet operational capabilities. The successful completion of OPEVAL led the Super Hornet to a milestone III decision and approval for full-rate production and multi-year procurement.

F-14 TOMCAT. The Navy has developed a strong, fully funded, executable program through the now short remaining life of the F-14 TOMCAT. The strength of the F-14/LANTIRN program has been ably demonstrated and has provided a firm bridge to F/A-18F. The Navy still intends to retire the F-14A force by 2003, the F-14B force by 2007, and the F-14D by 2008.

The **Common Support Aircraft (CSA)** has been envisioned to be a common airframe replacement for the E-2C, S-3B and ES-3A carrier-based aircraft. The program is currently being reexamined in light of the Navy's modernization goals and various platform upgrade options. If funding is approved, the CSA is expected to provide the fleet with C^3I, early warning, and electronic surveillance capabilities. At the current time the Navy has deferred a formal acquisition plan for the CSA until the critical issues of resources, requirements and program timing have been resolved. Until funding is approved, or the program is cancelled, it may be more appropriate to call the program a Common Support Concept (CSC) which accommodates efforts to tailor carrier-based support missions to the battlespace of the future. The spectrum of solutions for support aircraft modernization does not entail only new aircraft platforms. Current S-3 and C-2 airframe test articles will further define service life limits and alternatives. Support aircraft program initiatives such as the E-2 Multi-Year Procurement, vertically cutting the ES-3A, and shedding S-3B mission areas have succeeded in pushing the requirement for a Common Support Aircraft further into the future. The conclusions of ongoing analysis will be used to determine future direction of the CSA concept and to move forward with the most cost effective approach for modernizing naval aviation's support aircraft inventories.

An **Unmanned Air Vehicle (UAV)** effort is being pursued by all of the services as well as the Defense Advanced Research Projects Agency (DARPA). Additionally, several of the Services' battle labs are engaged in experimentation with UAVs. The Navy has just started a Vertical Takeoff and Landing UAV (VTUAV) program to meet its tactical requirements. Initial Operational Capability for the VTUAV is scheduled for FY03. In February 2000 the Navy's Program Executive Office (Cruise Missiles and Unmanned Aerial Vehicles) awarded an Engineering & Manufacturing Development contract for the VTUAV. The platform will provide real-time and near real-time data required to support intelligence, surveillance, and reconnaissance tactical needs. Its vertical launch and recovery capabilities will give the Fleet unique operational assets. The Navy expects this system to perform a variety of roles, including the ability to conduct detailed area surveillance and reconnaissance and battle damage assessment. It will also be able to identify targets, relay communications, conduct chemical or nuclear monitoring, and provide naval gunfire support. In addition to the VTUAV effort the Navy is funding a concepts study for integration of a Medium Altitude Endurance (MAE) UAV into the naval strike warfare capability.

The **Marine Corps Warfighting Lab** has on-going projects experimenting with a variety of UAVs. The Dragon Drone project demonstrated the utility of deploying a small UAV with small units and forward deployed forces. The Dragon Warrior project is developing a prototype small VTOL UAV that will be optimized for urban terrain. Finally, the Broad Area Unmanned Responsive Resupply Operations (BURRO) is a project to demonstrate the feasibility of applying unmanned technology to a full sized helicopter for external resupply operations.

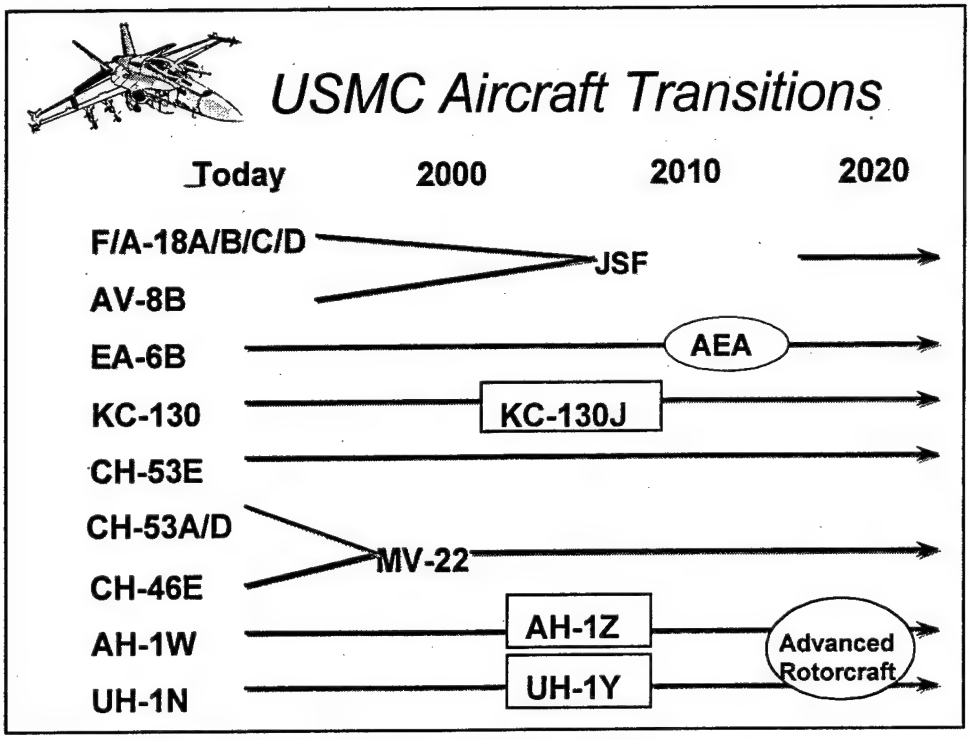

Figure 3: Marine Corps Aircraft Transitions

The **V-22 Osprey** is a multi-mission, medium-lift, Joint Service tiltrotor aircraft, the first ever tiltrotor in production. The program is currently in Low Rate Initial Production (LRIP) with Full Rate Production planned for FY01. The V-22 promises to provide the warfighter with unprecedented flexibility and responsiveness through its speed, payload, range, and survivability capabilities. Currently in OPEVAL, the Osprey is expected to meet or exceed all Service requirements. The tiltrotor technology inherent in the V-22 marks the beginning of the future. This unique and revolutionary technology offers unlimited potential for science and technology growth that may be applied in numerous joint applications.

The **Joint Strike Fighter (JSF)** is a tri-service, multi-role tactical aircraft and is the Marine Corps' number one acquisition priority. JSF is currently in the concept demonstration phase, which will feature flying demonstrator aircraft (Boeing's X-32 and Lockheed Martin's X-35), concept-unique ground and flight demonstrations, and continued refinement of contractor's weapon systems concepts. The Services approved the Joint Operational Requirements Document (JORD) in early 2000. Pratt and Whitney commenced engine testing in the summer of 1998 for Boeing and Lockheed Martin demonstrator aircraft, with tests meeting or exceeding expectations. General Electric is also developing an alternate engine for the program. A milestone decision to commence Engineering and Manufacturing Development (E&MD) is planned for the first quarter of 2001. The JSF will IOC in 2010 for the USMC, 2011 for the USAF and 2012 for the USN.

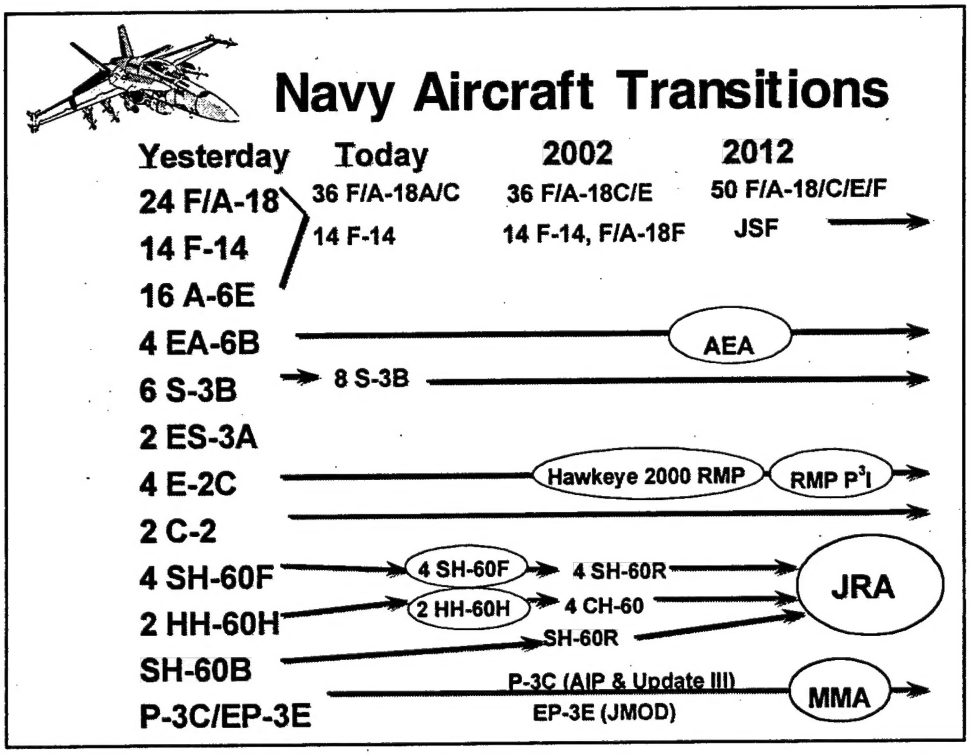

Figure 4: Navy Aircraft Transitions

The **SH-60R** is being developed to effect Navy platform commonality (currently two model types, the SH-60B and SH-60F) and to improve sensor capability, providing the USN with a robust multi-mission capability well into the next century.

The **EA-6B** fleet inventory is improving and increased to 103 of a PAA of 104 jets as of March 2000. Prowler inventory and readiness issues are steadily improving, and the platform's engines will be overhauled at NAS Whidbey Island. Current use of the EA-6B for all DOD Electronic Warfare missions has required close joint service cooperation. Recent lessons learned from Operation Allied Force has highlighted the EA-6B's key role in providing EW support for all strike aircraft. The Prowler will require a replacement in the post 2010 time period. The services are currently working on a joint Analysis of Alternatives (AoA) to determine the best approach.

The **E-2C** began a five-year Multi-Year Procurement in FY99. The procurement plan is for 21 aircraft to be in a Hawkeye 2000 compatible configuration, which consists of cooperative engagement capability (CEC), new mission computer, new workstations, satellite communications, upgraded equipment cooling, upgraded navigation system, and upgraded standard automatic flight control system. The modernized system will center on CEC, which brings significant benefits to all air defense areas, including improvements in track accuracy, continuity, and identification consistency. This capability will provide an identical picture to all CEC capable units, increasing battle space awareness, reducing reaction time, and extending engagement ranges. The Hawkeye 2000 is presently in flight test with all results meeting goals.

Weapon Technology Roadmaps

Naval Aviation possesses numerous types of air-to-air and air-to-ground strike weapons, all of which are designed for different targets, levels of accuracy, and missions.

Close-In Weapons. Weapons such as the Mk-80 series General Purpose (GP) bomb family, Rockeye, Gator, and 2.75" and 5" rockets are close in, direct-attack, unguided munitions. Close-in precision-guided munitions (PGM), such as Laser-Guided Bombs (LGB), AGM-65 Mavericks, and Hellfire II improve weapon lethality via increased accuracy.

The **Joint Direct Attack Munition (JDAM)** currently under development is a multi-service effort to develop a strap-on, GPS-aided Inertial Navigation System (INS) guidance kit that will improve the accuracy of GP bombs in all weather conditions. JDAM also will allow a single aircraft to attack multiple targets from a single release point.

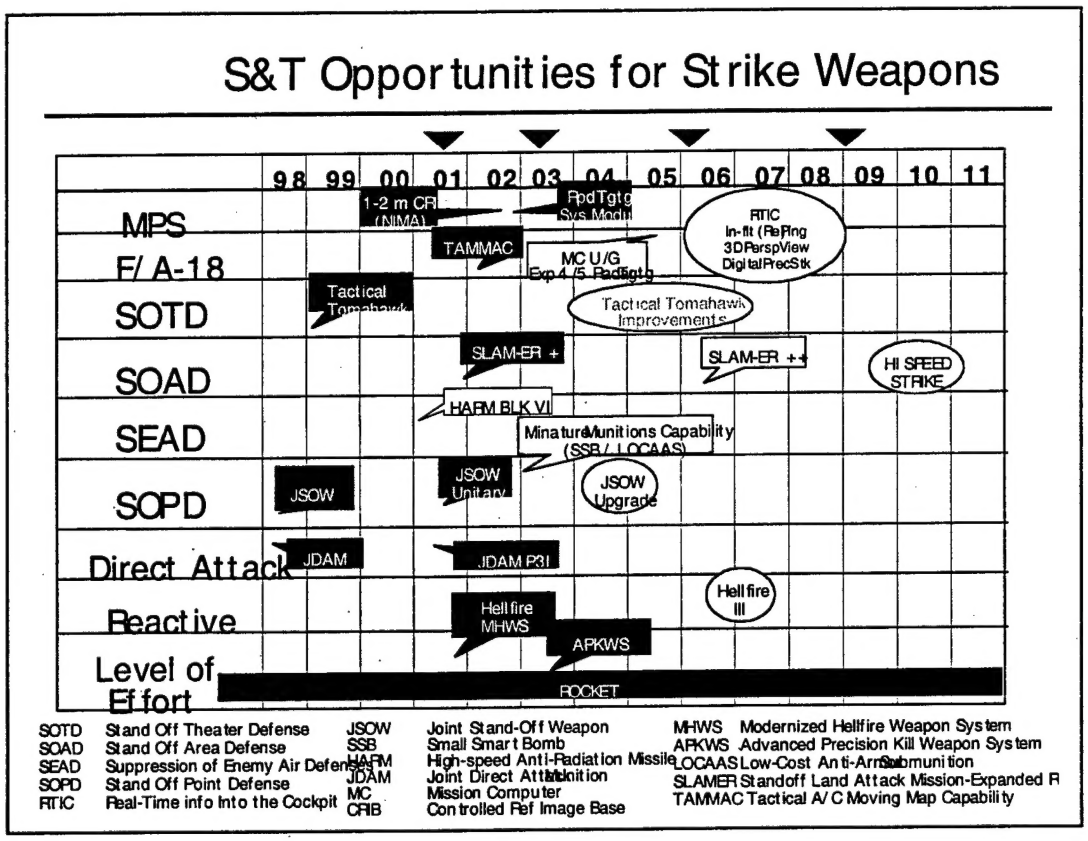

Figure 5: S&T Opportunities for Strike Weapons

Stand-Off Weapons. Point-defense surface-to-air missiles comprise approximately 85 percent of the weapons that make up enemy integrated air defense systems. Naval Aviation's ability to attack targets from beyond the range of these systems is met by the AGM-88 HARM (High-speed Anti-Radiation Missile), SLAM (Stand-off Land Attack Missile), and the AGM-62 Walleye. These weapons acquire and home in on their targets using various techniques,

including passive homing on radar and radio emitters (HARM) and electro-optics in the visible (Walleye) and infrared (SLAM) spectra. However, these provide limited adverse weather capability and carry only a unitary warhead for attacks against point targets. HARM has shown great flexibility and continues to be upgraded; the Navy is currently incorporating Block V and VI modifications into the missile, giving it the capability to attack GPS jammers and adding an INS/GPS suite. Walleye, developed in the 1960s, will be phased out of the inventory by 2005.

Joint Stand-Off Weapons. A new family of Stand-off Outside Point Defense (SOPD) weapons was introduced to the fleet in FY 1998, beginning with the Joint Stand-Off Weapon (JSOW). JSOW is another multi-service program that will replace five types of the older air-to-ground weapons currently in the naval inventory. It will provide a family of near precision-guided weapons that will allow naval aircraft to attack area as well as point targets at increased standoff distances, thus greatly increasing aircraft survivability. JSOW will be usable in adverse weather conditions and, like JDAM, will give aircrews the ability to attack multiple targets in a single sortie.

SLAM/SLAM-ER (Expanded Response). SLAM-ER is Naval Aviation's follow-on to the SLAM Stand-off Outside Area Defense weapon. It is a day/night, adverse-weather, precision-strike weapon with over-the-horizon range. SLAM is an anti-ship missile with a GPS-aided INS system for mid-course guidance, an Imaging Infrared sensor and a data link for precise, "man-in-the-loop" terminal guidance. SLAM-ER is an evolutionary upgrade of SLAM, providing the Navy and Marine Corps with a major improvement in precision strike capability. SLAM-ER+ will incorporate Advanced Terminal Guidance (ATG), making it an autonomous weapon, and enhancing the missile's capability against small targets and targets in urban environments. SLAM-ER weapons fitted with ATG will be fielded in the 1999-2000 timeframe.

The **AIM-120 AMRAAM** is the Air Force and Navy's Advanced Medium Range Air-to-Air Missile. A suite of upgrades for the AMRAAM include the rocket motor, warhead, target detector, advanced seeker, ECCM and a new guidance system.

The **AIM-9 Sidewinder** is the Navy and Air Force's short-range infrared-guided air-to-air missile. The latest upgrade to the AIM-9L/M family is the AIM-9X configuration, which is currently undergoing operational testing. Future system upgrades include motorcases, infrared counter-counter-measures improvements, and kinematics and lethality improvements.

FUTURE NEEDS

Possible Air Wing Changes

Naval Aviation leaders are exploring sweeping changes in carrier aviation, changes that would radically alter the makeup of Naval air wings. Deployment changes being explored include reducing the number of strike fighters by 10 percent per wing and forging a more powerful force off the flight deck. Each carrier air wing could shrink by as many as six strike fighters (from 56 to 50) in the coming years. The decrease in airframe numbers would be compensated by mission and operational advances anticipated with the incoming F/A-18E/F Super Hornet (scheduled to join the fleet in two years), as well as upgrades to several current platforms. The cost savings realized from shrinking the air wing could conceivably pave the way

for an 11th carrier air wing. Currently, 10 wings rotate to respond to the needs of 12 aircraft carriers. An additional (11^{th}) air wing would greatly mitigate operations tempo on the existing wings as the heavy dependence on air strikes is not expected to change significantly.

Future Naval Capabilities

In June, 1999, the Navy approved a new investment process for the DoN Science and Technology (S&T) Program. This new S&T process focuses on achieving a long-term view not anticipated by currently perceived Naval needs as well as addressing nearer-term Future Naval Capabilities (FNC). Under this new process approximately half of the DoN S&T budget will be focused on carefully selected investment programs; these programs will develop and demonstrate those advanced technologies that address and enable the high priority Future Naval Capabilities. Transition sponsors will be closely coupled to the FNC's to ensure that the capabilities are delivered to the fleet in a more aggressive and timely manner.

At the time of the establishment of this new S&T investment process, a list of twelve FNC emphasis areas was approved by the DoN Corporate S&T Board. An Integrated Product Team (IPT) was formed for each FNC. Led by flag level personnel, each FNC IPT defined specific Enabling Capabilities, prioritized those capabilities, performed a technology assessment and identified technology gaps, and began the development of an appropriate S&T program which will enable those future capabilities to be realized, demonstrated, and transitioned to the fleet. The twelve FNCs are:

- Platform Protection
- Littoral Anti-Submarine Warfare
- Decision Support Systems
- Information Distribution
- Time Critical Strike
- Expeditionary Logistics
- Capable Manpower
- Warfighter Protection
- Autonomous Operations
- Total Ownership Cost
- Missile Defense
- Organic Mine Countermeasures

This new investment process continues to evolve as this brief description goes to print. In November 1999 a final prioritization of the FNC emphasis areas was released, as was a proposed S&T technology investment program. The S&T investment program includes the active coordination with, and leveraging of, appropriate science and technology investments by other Services and Federal Agencies. The Navy's POM-02 budget will provide the first opportunity to implement the S&T program changes which result from this new process.